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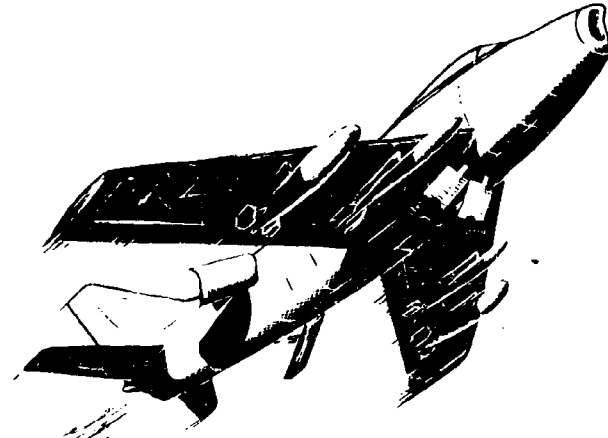
REPORT NO. NA-53-96

AD NO. 3/53
ASTIA 817 004

IMPROVED

F-86F

**COMBAT
DEVELOPED**



NORTH AMERICAN AVIATION, INC.

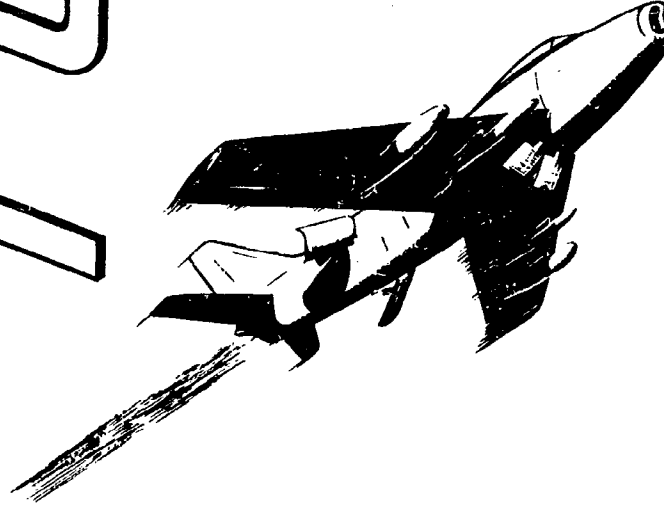
SECURITY INFORMATION—CONFIDENTIAL

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REPORT NO. NA-53-96
JANUARY 28, 1953

F-86F

IMPROVED



**COMBAT
DEVELOPED**



NORTH AMERICAN AVIATION, INC.
INTERNATIONAL AIRPORT • LOS ANGELES 45, CALIFORNIA

SECURITY INFORMATION—CONFIDENTIAL

PREFACE

The latest models in the production F-86 series are the F-86F-25 and 30's. These are dual-store aircraft - that is, they can carry various armament at an inboard wing station in conjunction with the external fuel tanks at an outboard wing station.

The versatility of the combat-tested F-86 series has therefore been extended to embrace the fighter-bomber category.

The purpose of this presentation is to report that NAA has developed significant improvements for this new role of the F-86; that these improvements allow the full ground support potential of the F-86 to be realized, and that the current F-86, so equipped, emerges as a truly formidable and dependable weapon available today to the USAF.

Improvements are emphasized in this report. More detailed information on general fighter-bomber capabilities are presented in report No. NA-52-728, dated August 1, 1952, revised December 12, 1952.

Section 1

Summary

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SUMMARY

Prior to the delivery of any dual-store F-86F aircraft, it was felt that a general flight evaluation of this latest F-86 configuration would be highly desirable. In this way the effectiveness of the F-86F in the changing and improving field of jet fighter-bomber work might be anticipated, and means for improving its strike-ability developed.

An Engineering Flight Test F-86E airplane was therefore modified to simulate the F-86F, and an intensive test program initiated. The following facts were discovered:

- 1) The probable target entry and exit speeds were adequate, however, tracking time for steeper dive angles which are desirable for accuracy and less vulnerability was barely enough for good tracking.
- 2) The A-4 bomb sight provisions alone were found decidedly unsatisfactory, in that they required a curvilinear flight path which was difficult to fly, and the dispersion inherent in the system was very high (44 mils).

The improvement for item (1) was found by installing belly brakes and enlarging the size of the existing aft side speed brakes. This new dive brake configuration allowed the entry altitude to be as low as 10,000 feet for a near

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vertical dive with adequate tracking time and pull-out clearance.

The improvement for item (2) was found by the introduction of Manual Pip Control, a Bombing Altimeter, and Canopy Lines for dive angle indication. This bomb sight system uses the A-4 sight as installed, and merely introduces Manual Pip Control by means of a switch. With this system it has been demonstrated conclusively that dispersion is reduced to one-third of that for the A-4 system.

In addition to these strike-ability improvements, which are described on subsequent pages, it is pointed out that the armament versatility will be increased by special store provisions, and the radius potential improved with a modified leading edge that can be adapted for additional fuel capacity.

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Section 2

Configuration Changes for Improved Combat Effectiveness

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NEW BELLY DIVE BRAKES

The new belly brakes are shown in the pictures on the following pages. They have a maximum opening of 50°, and a total area of 12.5 ft². These brakes increase the basic airplane drag by slightly more than a factor of four! As shown by the photographs, ground interference would be encountered during landing if the brakes were open, therefore, provisions are incorporated to retract them when gear lowering is initiated. These brakes are actuated by the same type of hydraulic cylinders and pistons used for the standard side speed brakes, and the complete assembly can be installed as a kit and, once installed, can be removed and replaced with the standard belly pan in approximately 2 hours.

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NEW BELLY DIVE ROOM

ENTER DIVE
THIS ST.

ALL THIS TALK?



NEW BELLY DIVE BRAK

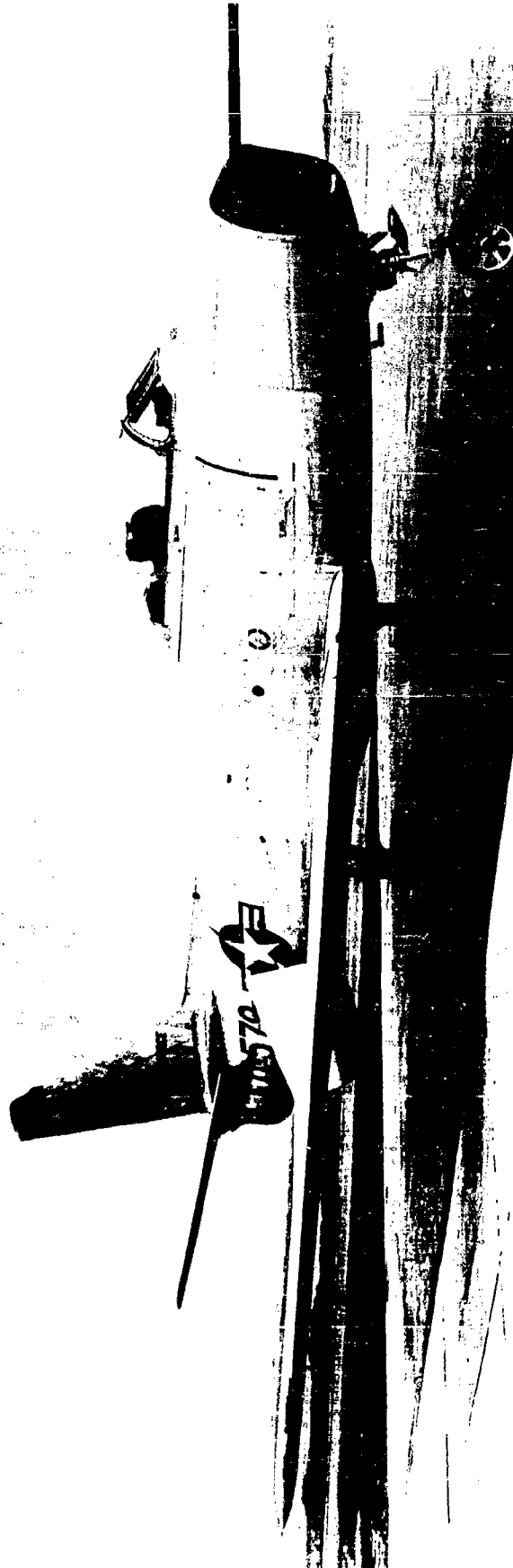
3-281

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NEW SIDE DIVE BRAKES

The new, enlarged side dive brakes for the F-86F are shown in the picture on the following page. Their area has been increased from 11 ft² to 21 ft², and their deflection remains at the standard 50° value. These brakes are obtained by placing a 3/16" thick contoured and chamfered sheet of Alclad over the standard side brake, and strengthening the support installation in two locations. The actuation system remains the same. The drag of the basic airplane is increased by a factor of about three and a half by these new brakes.

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NEW-GIDE DIVE BRAKES F-86E # 579

1-19-53

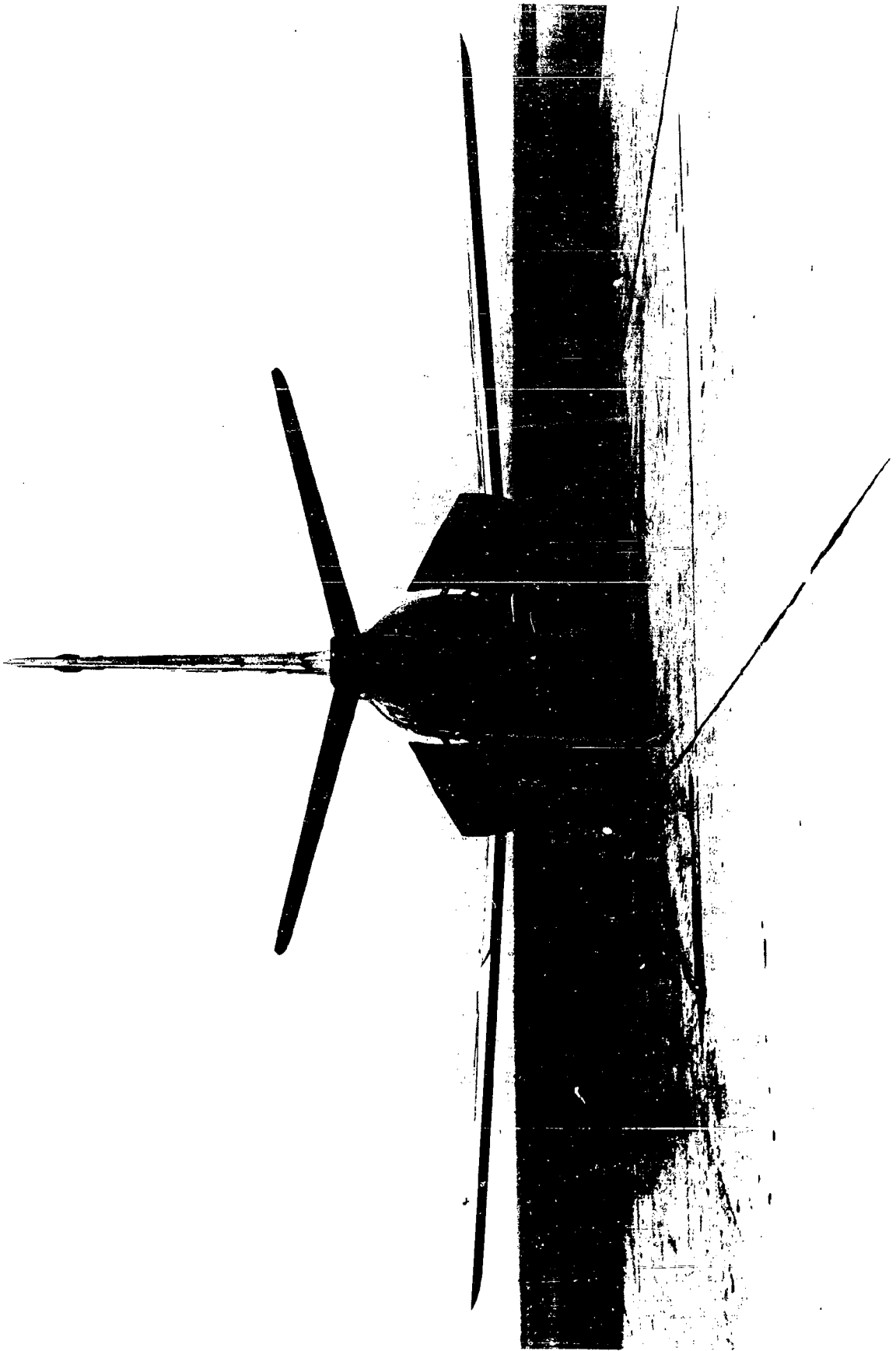
191-92-28H

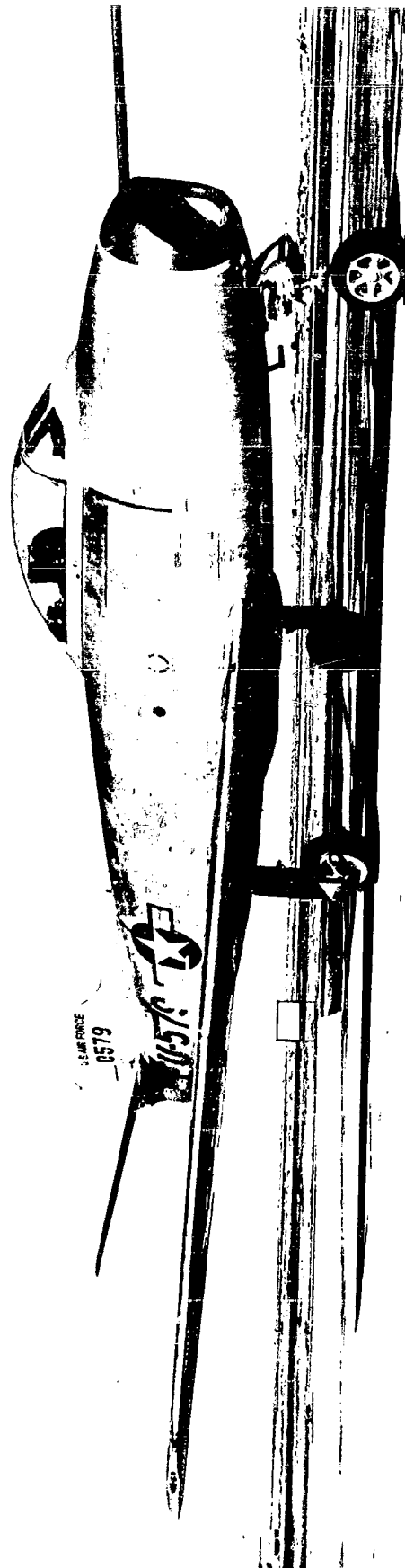
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NEW BELLY AND SIDE DIVE BRAKES

In order to show the total effect of the new F-86F brake configuration, both open and closed, the pictures on the following pages are presented. The total effect of these new brakes when opened is to increase the basic airplane drag by a factor of about seven, as compared to the original (side) brakes which gave a factor of two and a half. As can be surmised from the photograph, the brakes-closed position has a negligible effect on performance. The final decision as to the desirability of using both new side dive brakes and belly dive brakes or combinations thereof is to be made from current flight tests.

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NEW BELLY & SIDE DIVE BRAKES CLOSED F-86E # 579

1-14-53

191-90-28 D

MANUAL PIP CONTROL UNIT

The Manual Pip Control unit provides a control which will electrically depress the A-4 sighting reticle through a range of 0 to 170 mils. The on-off toggle switch on the right side of the unit activates the MPC. When this switch is in the "Normal" position, the A-4 sight operates in the conventional manner; placed in the "Bomb" position, the MPC takes over control of the Pip and fixes it in electrical cage, at the depression selected by the knob control.

The MPC unit has been provided with four dials, one fixed on the face, and three others which fold down over the control knob. The fixed dial is calibrated in mils of lead angle; operation of the knob depresses the sighting reticle to any desired value from 0 to 170 mils.

The three folding scales represent three initial entry conditions of given airspeeds and altitude.

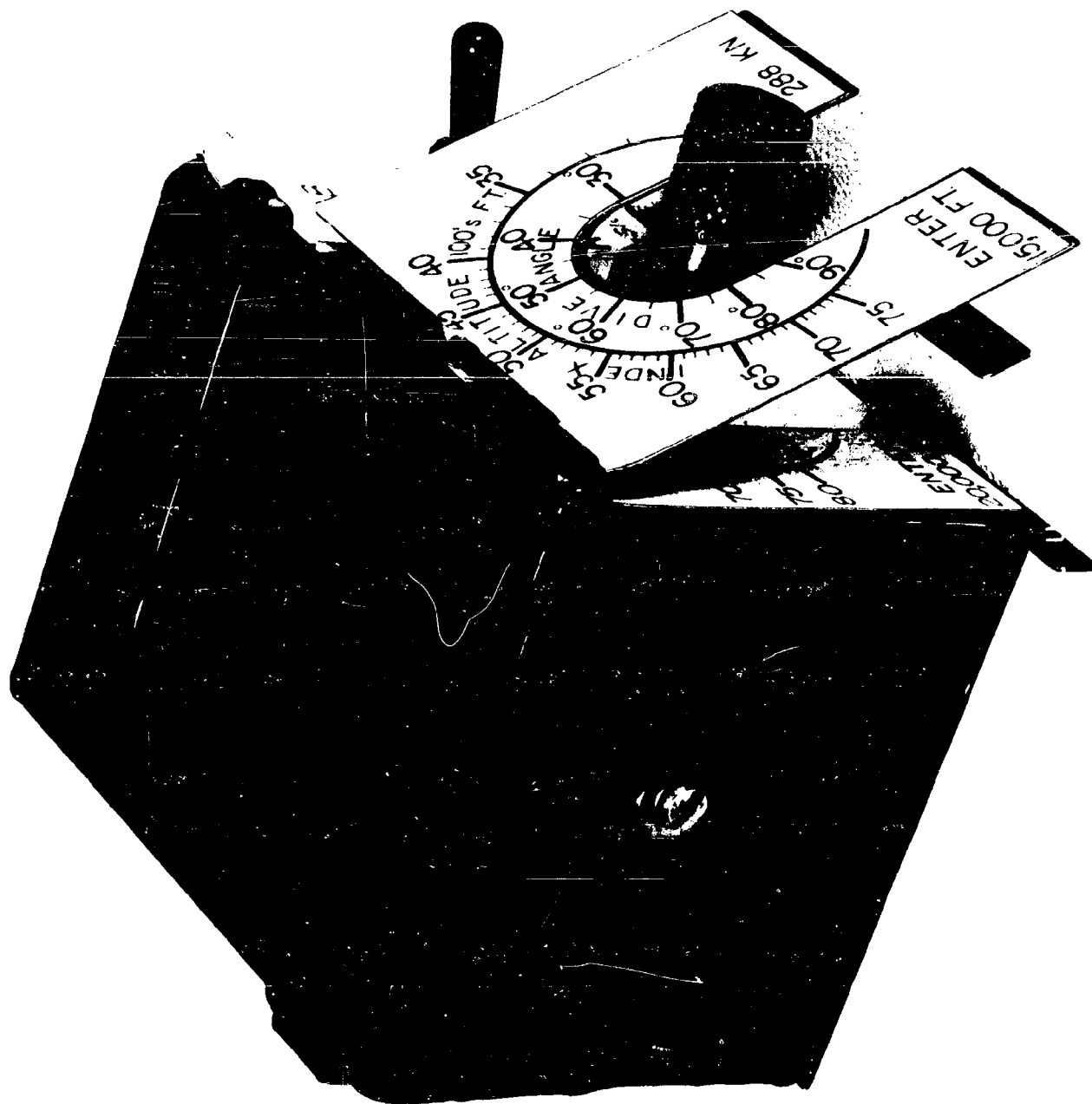
<u>Altitude Above Target</u>	<u>Indicated Airspeed</u>
10,000	305 knots
15,000	288 knots
10,000	270 knots

The inner scale shows "Dive angle" and the outer scale "Index Altitude" which gives the correct bomb release altitude above a sea level target. These

scales have been calibrated in terms of the F-86F Fighter dive characteristics when equipped with external tanks and bombs, with the brakes extended and power control in idle setting; for a terrain clearance of 2500 feet with a 5.0 g dive recovery.

If the entry conditions noted above are followed, the airspeed at any point during the dive is known, and the required release altitude, lead and terrain clearance for the chosen dive angle are determined. A range of dive angles between 20° and 90° is available.

These scales have been calibrated for the F-86F with standard dive brakes. With the larger side brakes and belly brakes the scales will be recalibrated. Preliminary tests indicate that a terminal velocity of approximately 370 knots is reached with the added brakes - thus reducing the number of scales in the MPC. In effect this holds one of the three variables of the dive bombing problem constant, making for simplicity and more accuracy.



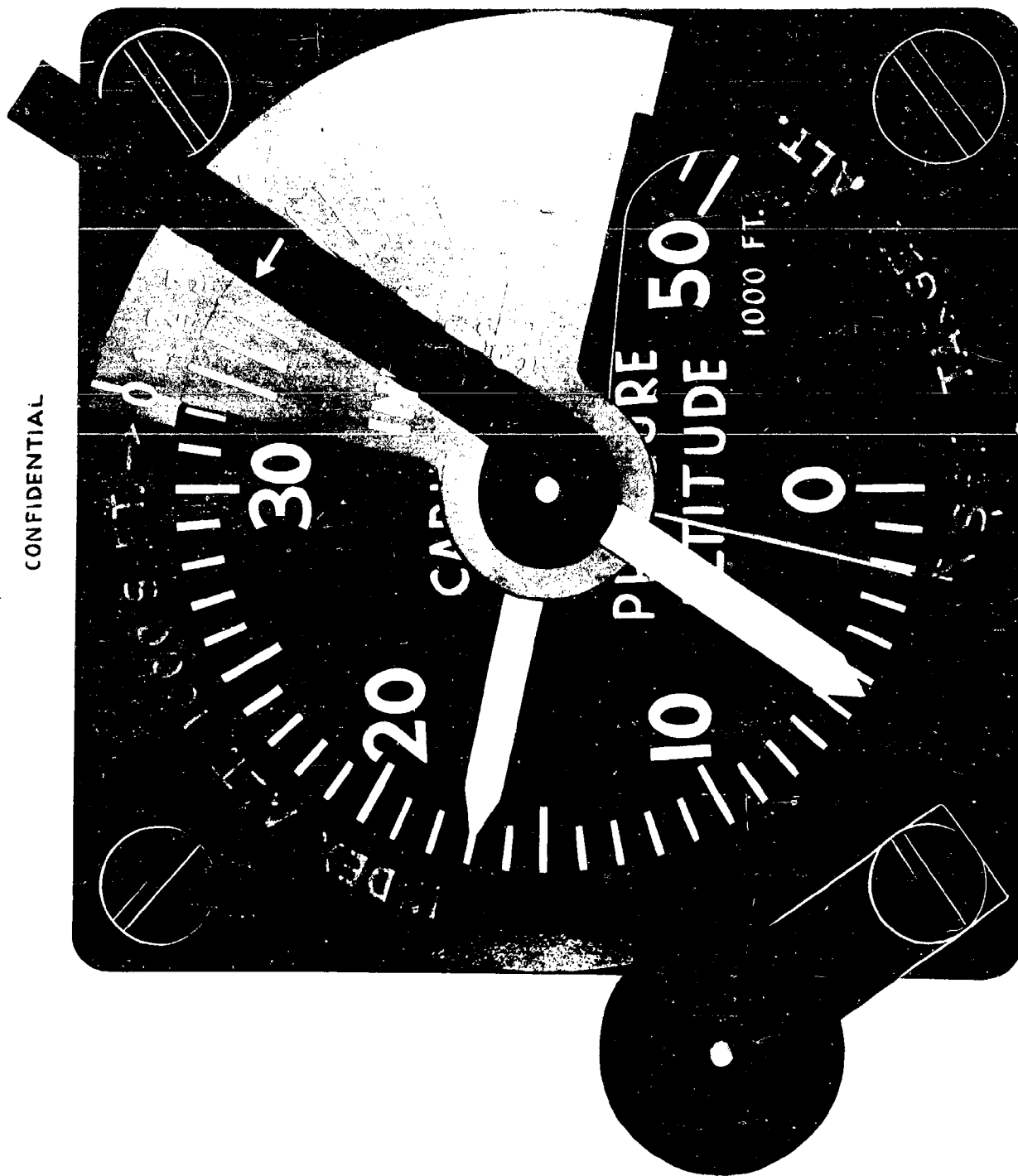
BOMBING ALTIMETER

The bombing altimeter consists of a standard cabin altimeter with an index altitude scale attached to the face. This altimeter is connected to the ship's static system and indicates airplane pressure altitude. The principal purpose of the bombing altimeter is to give the pilot an accurate and safe bomb release and pull-out indication. The altimeter is placed immediately adjacent to the A-4 sight reflector plate where it may be seen with a minimum of distraction from the target tracking operation.

"Index altitude", which is obtained from the manual pip control unit dial for the required entry condition, is placed on the "Index Altitude" scale on the bombing altimeter. Target altitude is placed on the face of the instrument by rotating the knob on the lower left side, so that the arrow marked "Set target altitude" indicates the required figure.

The result of these two operations is to position the white pointer over the face of the instrument dial at the correct release altitude above the actual target. When the altitude indicating needle coincides with the white release pointer during the dive, bombs are released and dive recovery initiated.

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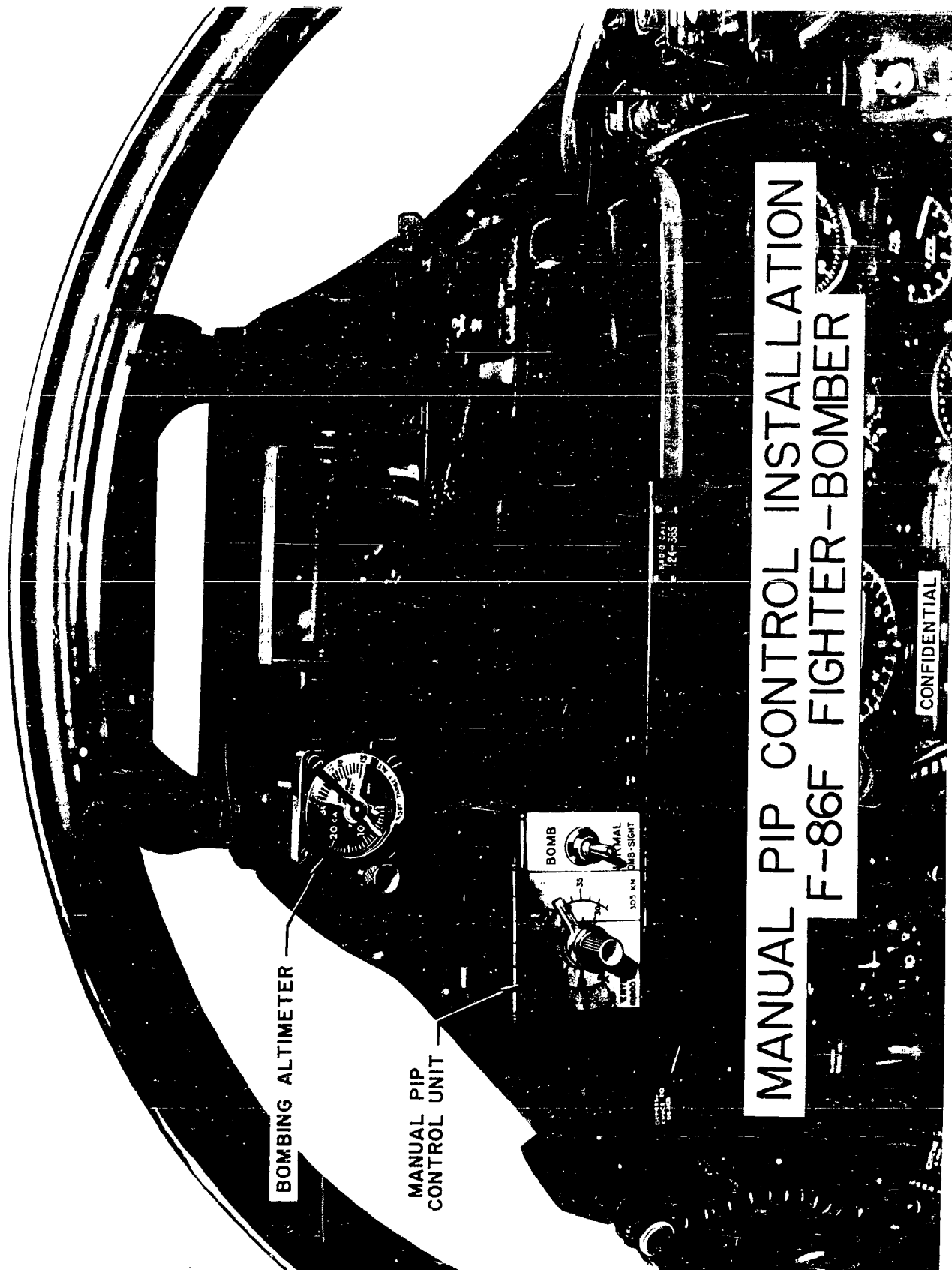


BOMBING ALTIMETER

MANUAL PIP CONTROL INSTALLATION

The Manual Pip Control units have been grouped on the instrument panel shroud to eliminate the dangerous necessity of looking down at the instrument panel altimeter or airspeed indicator during a dive bombing attack. The pilot's entire attention is concentrated in the region of the gun sight.

The MPC unit and bombing altimeter are readily available to the pilot, convenient for left hand operation, and placed so that forward vision is unimpaired. The altimeter is mounted just to the left of the A-4 sight reflector plate such that the pilot is able to track the target, yet with minimum change of eye position, observe the rate of change of the altitude pointer and detect the bomb release point accurately. If it becomes necessary for the pilot to change the MPC setting during a dive, it may be accomplished with a minimum of distraction from the primary item of importance, the target.



BOMBING ALTIMETER

MANUAL PIP
CONTROL UNIT

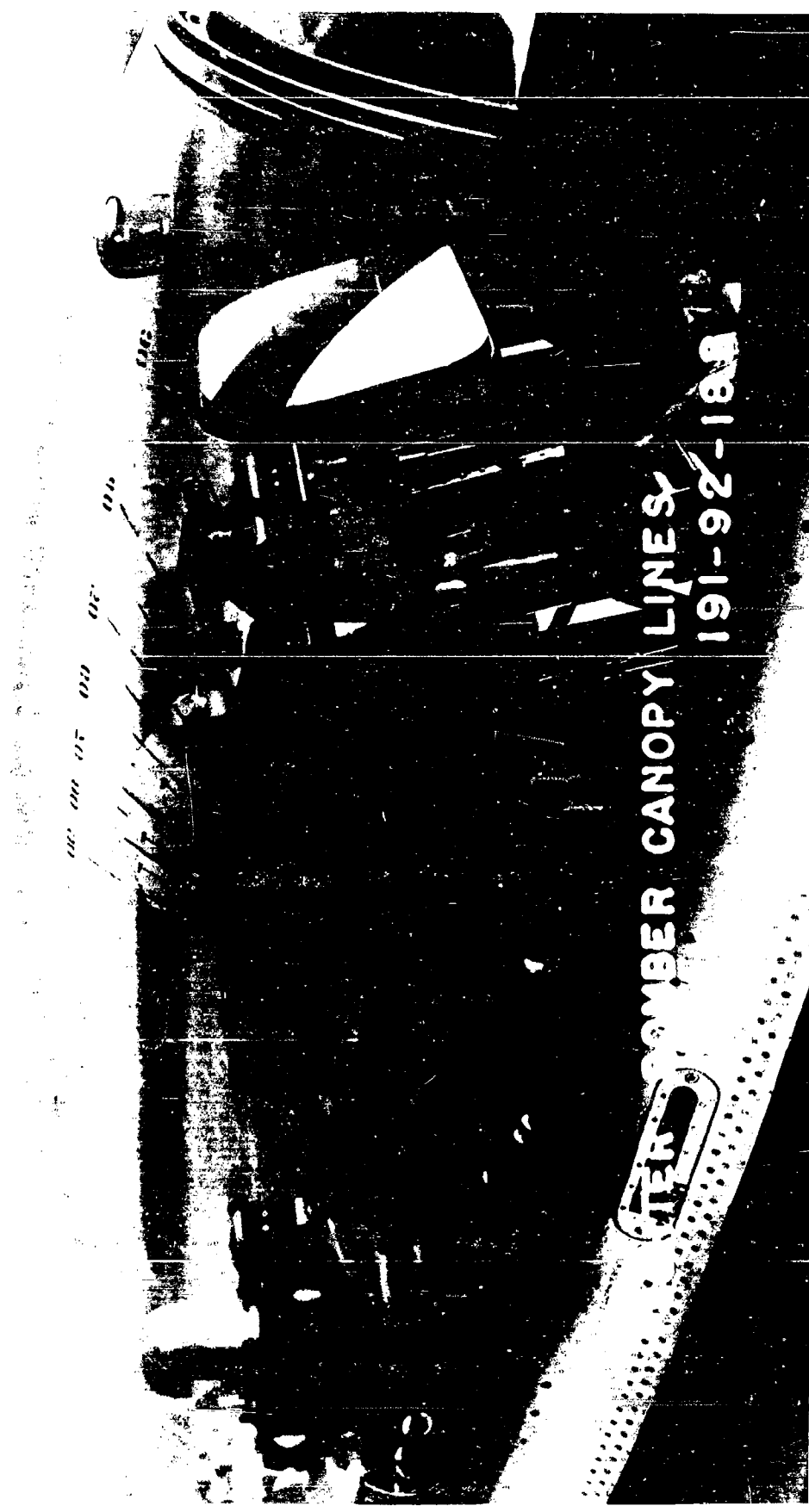
MANUAL PIP CONTROL INSTALLATION
F-86F FIGHTER-BOMBER

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CANOPY LINES

The lines placed on the pilots canopy are provided to give a means of rapid check on dive angle. Given in ten degree increments between zero and ninety degrees, the lines originate at a point opposite the pilot's eye position when using the gunsight. The pilot reads the dive angle line nearest the horizon or some other horizontal reference such as the base of a cloud cover.

If the dive angle indicated by the canopy lines is considerably different (more than 10°) than that set on the Manual Pip Control Unit, the pilot can either stair-step his dive path to correct to the required value, or re-set the Manual Pip Control to the correct setting, and estimate the proper release point. With practice, it will be found that fewer canopy lines will be required, also the Contractor is investigating other means of determining dive angles.



STERLING CANOPY LINES
191-92-188

Section 3

Effect of Improvements on Aircraft Capabilities

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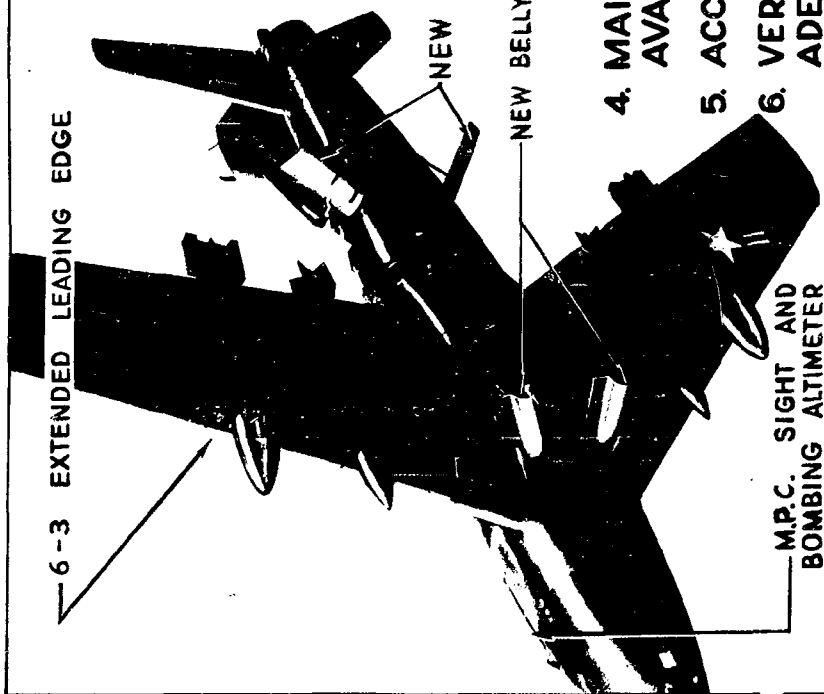
FEATURES

This first chart is presented as a brief summary of what is considered to be outstanding features of the improved F-86F fighter-bomber.

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F-86F IMPROVED FIGHTER-BOMBER

FEATURES



1. NO SPEED, MACH NO., OR ATTITUDE LIMITS.
2. NO JATO REQUIRED - STANDARD FIGHTER STRIPS.
3. LOGISTICS-PARTS AND ENGINES AVAILABLE ALL OVER THE WORLD.
4. MAINTENANCE-GROUND CREWS TRAINED AND AVAILABLE.
5. ACCURATE, SIMPLIFIED, RELIABLE SIGHTING.
6. VERTICAL DIVES WITH SPEED ADJUSTMENT FOR ADEQUATE TIME ON TARGET WITH MINIMUM VULNERABILITY
7. STANDARD AND SPECIAL WEAPON CAPABILITIES.
8. LONG RANGE CAPABILITY.
9. BY ACTUATING ONE SWITCH, THE EXTERNAL STORES CAN BE DROPPED, AND BY ACTUATING ANOTHER SWITCH THE SIGHT IS CHANGED FROM THE MPC UNIT TO THE STANDARD A-4 GUN SIGHT FUNCTIONS TO GIVE CLEAN AIRPLANE CAPABILITIES.

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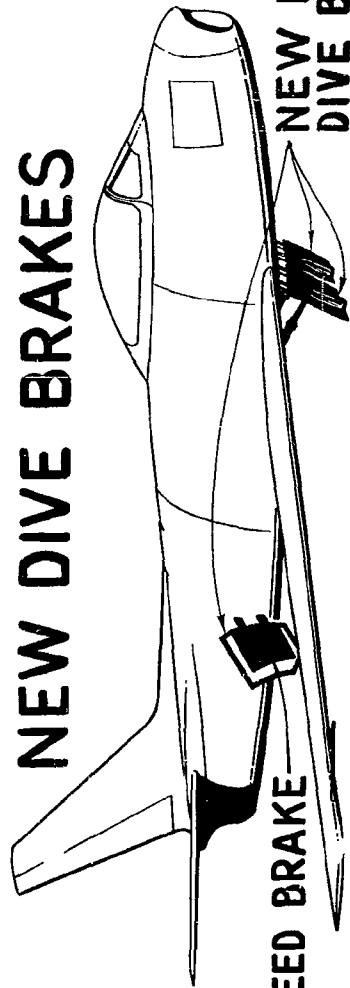
NEW DIVE BRAKES

This chart shows the effect of the increase in brake area on
airspeeds in a typical dive bombing run at a near vertical dive angle.

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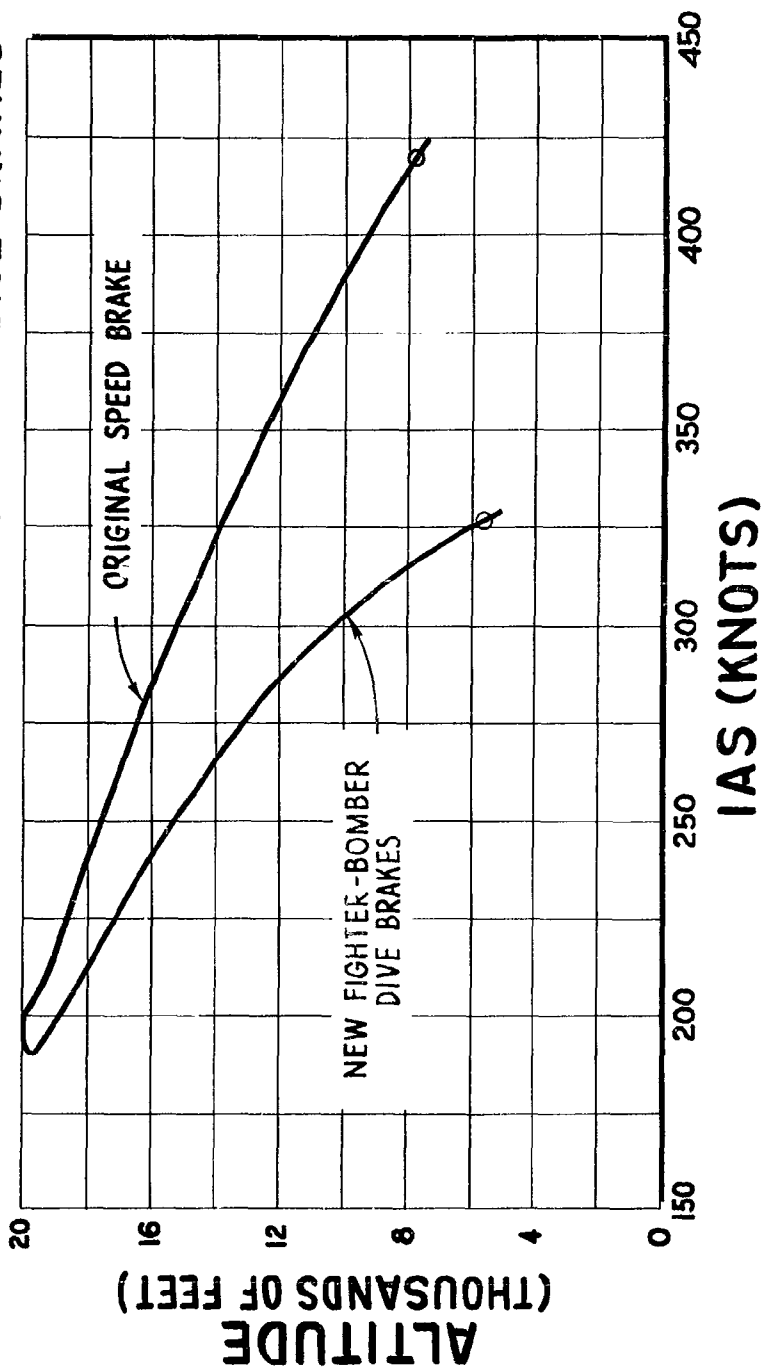
F-86F FIGHTER-BOMBER

NEW DIVE BRAKES



ORIGINAL SPEED BRAKE

NEW FIGHTER-BOMBER
DIVE BRAKES



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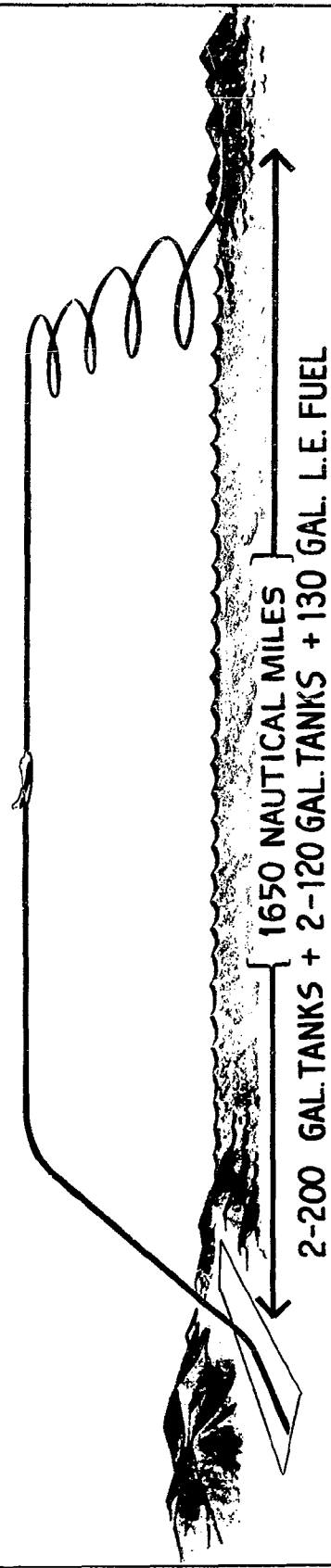
RADIUS & RANGE

The following chart shows a fighter-bomber radius and a ferry range. The so-called "Extended leading-edge" has been used, considering that it is modified to carry fuel, to show the excellent radius and range available with these configurations.

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F-86F FIGHTER-BOMBER

RADIUS AND RANGE



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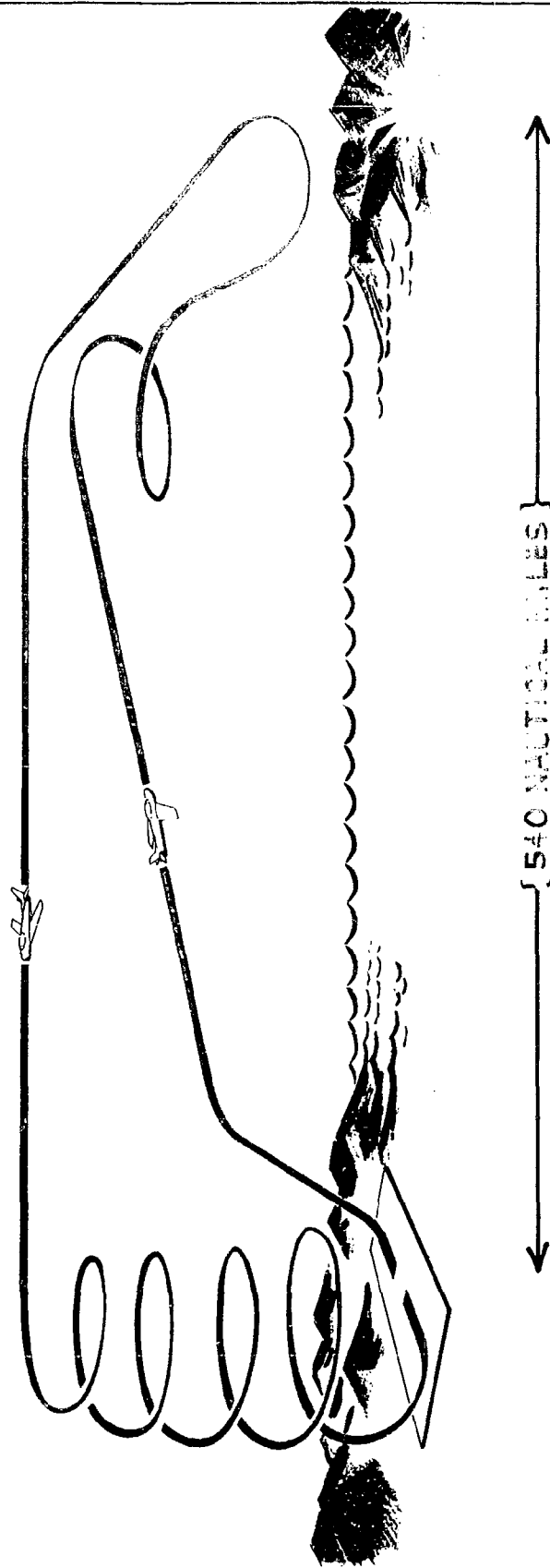
SPECIAL WEAPON RADIUS

The 1200 lb special store capability to be incorporated on the F-86F, and the radius value with this installation as shown on the following chart, is considered an outstanding feature. It is pointed out that the special store has been released at negative and positive "Q's" at very high Mach numbers without difficulty. Because of the store's excellent shape and stability, a low loss in radius and perfect drops are obtained.

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F-86F FIGHTER-BOMBER

SPECIAL WEAPON RADIUS



(200 GAL TANKS & 120 GAL TANK DROPPED)

2-200 GAL TANKS + 1-120 GAL TANK + 1-1200 LB. SPECIAL STORE + 130 GAL L.E. FUEL

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TAKE-OFF & LANDING

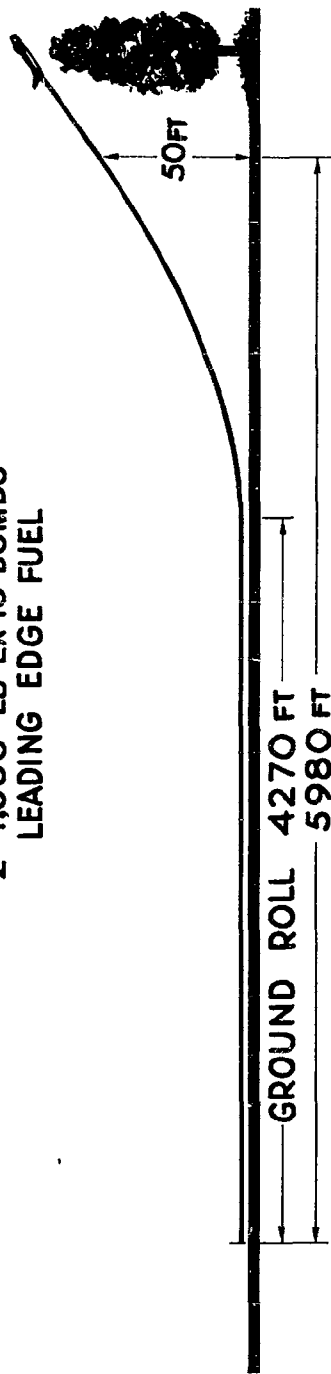
To illustrate the take-off requirements of a typical fighter-bomber configuration, the ground run and total distance to a 50 ft. height is shown on the following chart. A typical mission landing distance, assuming tanks have been retained, is also shown.

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F-86F FIGHTER-BOMBER

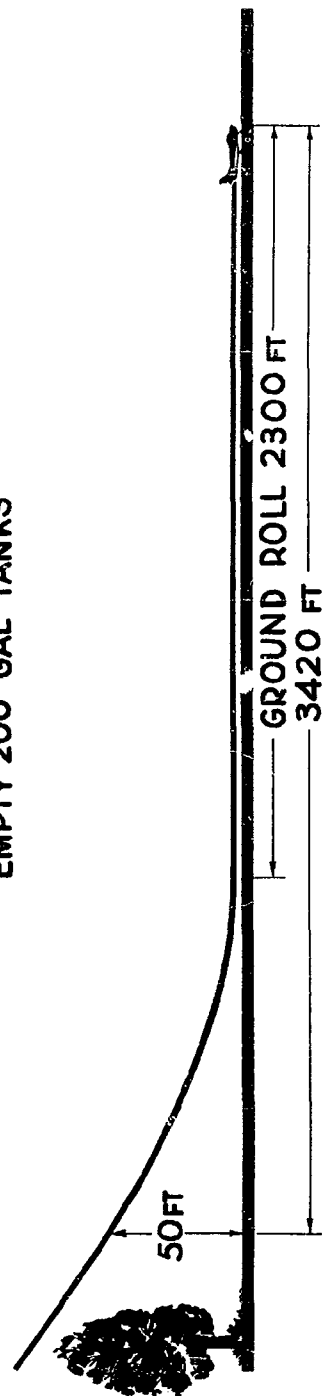
TAKE-OFF

2-200 GAL TANKS
2-1,000 LB EX 10 BOMBS
LEADING EDGE FUEL



LANDING

EMPTY 200 GAL TANKS



DIVE BOMBER CAPABILITY IMPROVEMENT

The following chart serves to illustrate the concept basic to the development of the improved F-86F. It was desired to obtain steep dive angles for reduced dispersion and vulnerability, and yet hold to reasonable speeds for sufficient tracking time. An added benefit of steeper dive angles is the ability to more effectively counter ground fire from the target by use of the aircraft machine guns. The new fighter-bomber dive brakes have accomplished this, and the high entry and exit speeds available with the F-86F also contribute importantly to reduced vulnerability.

To further illustrate this effect, a tracking time vs. dive angle comparison for the original and new brake configuration is shown. The improvement in tracking time is obvious. However, the improvement in entry altitude is a hidden feature; for it can logically be shown that with this increase in tracking time from one entry altitude, the fixing of one minimum required tracking time automatically means the entry altitude can be substantially lowered with the new fighter-bomber dive brakes.

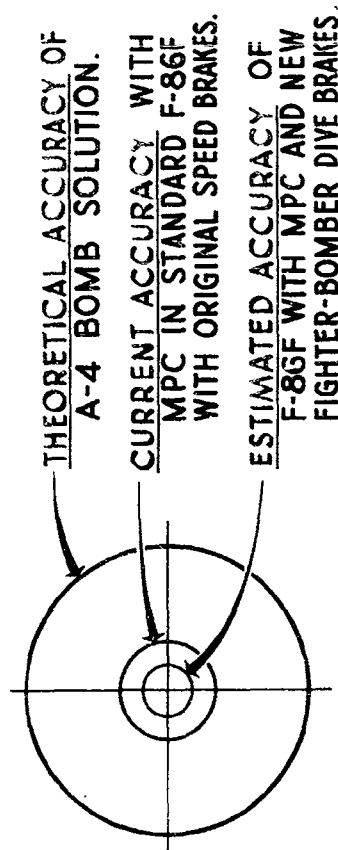
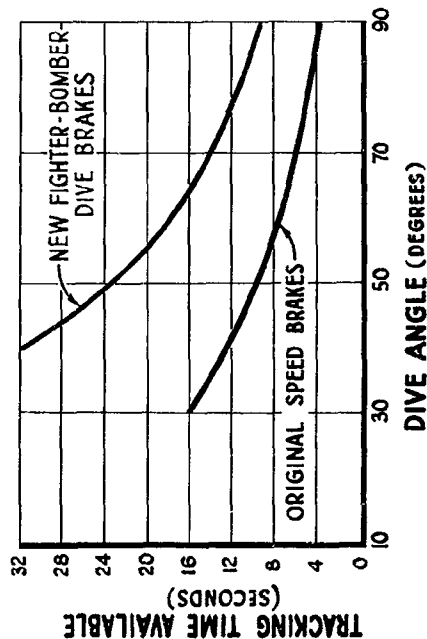
The amazing effect of the MPC sighting system is shown in the dispersion pattern presentation also on the chart. The estimated effect of the new dive brakes is also shown for comparison.

F-86F FIGHTER-BOMBER

DIVE BOMBING CAPABILITY IMPROVEMENT



EFFECT OF DIVE BRAKES ON DISPERSION AND TRACKING TIME



INCREASED TRACKING TIME AND CAPABILITY OF BOMBING FROM LOWER ALTITUDES IMPROVES ACCURACY.

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COMPARISONS OF BOMBING SYSTEMS

The manifest difficulties which have been encountered with use of the automatic bombing solution of the A-4 sight suggested that some improvement could be effected in the basic bombing system. The automatic solution is difficult to use since it imposes a prolonged period of 1/2 g flight on the pilot during the tracking run; and rough air is liable to cause premature release of the bomb due to erroneous inputs to the bombing computer.

A second solution to the bombing problem is the use of the rocket function of the A-4 sight to provide the required lead. By selection of combinations of wing span dial setting and rocket selections it was possible to provide the pilot with a series of leads for various dive angles and release altitudes.

Pilot tracking with the rocket solution was made difficult by the four second settling time of the sight. In addition the pilot was required to estimate the release altitude, or to watch the instrument panel altimeter, which diverts pilot attention from the gun sight, and makes smooth tracking more difficult.

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The MPC unit modification to the A-4 sight proposed for the improved F-86F eliminates these objections by providing the pilot a means of estimating dive angle (canopy lines), release altitude (bombing altimeter), and speed (MPC dials). This system allows bombing from angles of 20° to vertical (90°). Because the sight is electrically caged the settling time is less than a second, requiring minimum tracking time "on target." The flight path has a lesser degree of curvature and the pilot has a ready altitude reference for altitude safety. With these advantages come a high degree of accuracy not available in the other two systems.

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COMPARISON OF BOMBING METHODS



A-4 AUTOMATIC BOMBING SOLUTION

DIFFICULT TRACKING

PILOT DISCOMFORT DUE TO $\frac{1}{2}$ G FLIGHT

PREMATURE AUTOMATIC RELEASE IN ROUGH AIR

A-4 STADIAMETRIC SOLUTION (ROCKET FUNCTION)

DIFFICULT TRACKING

4 SECOND SIGHT SETTLING TIME

INCOMPLETE RANGE OF SIGHT SETTINGS FOR LEAD

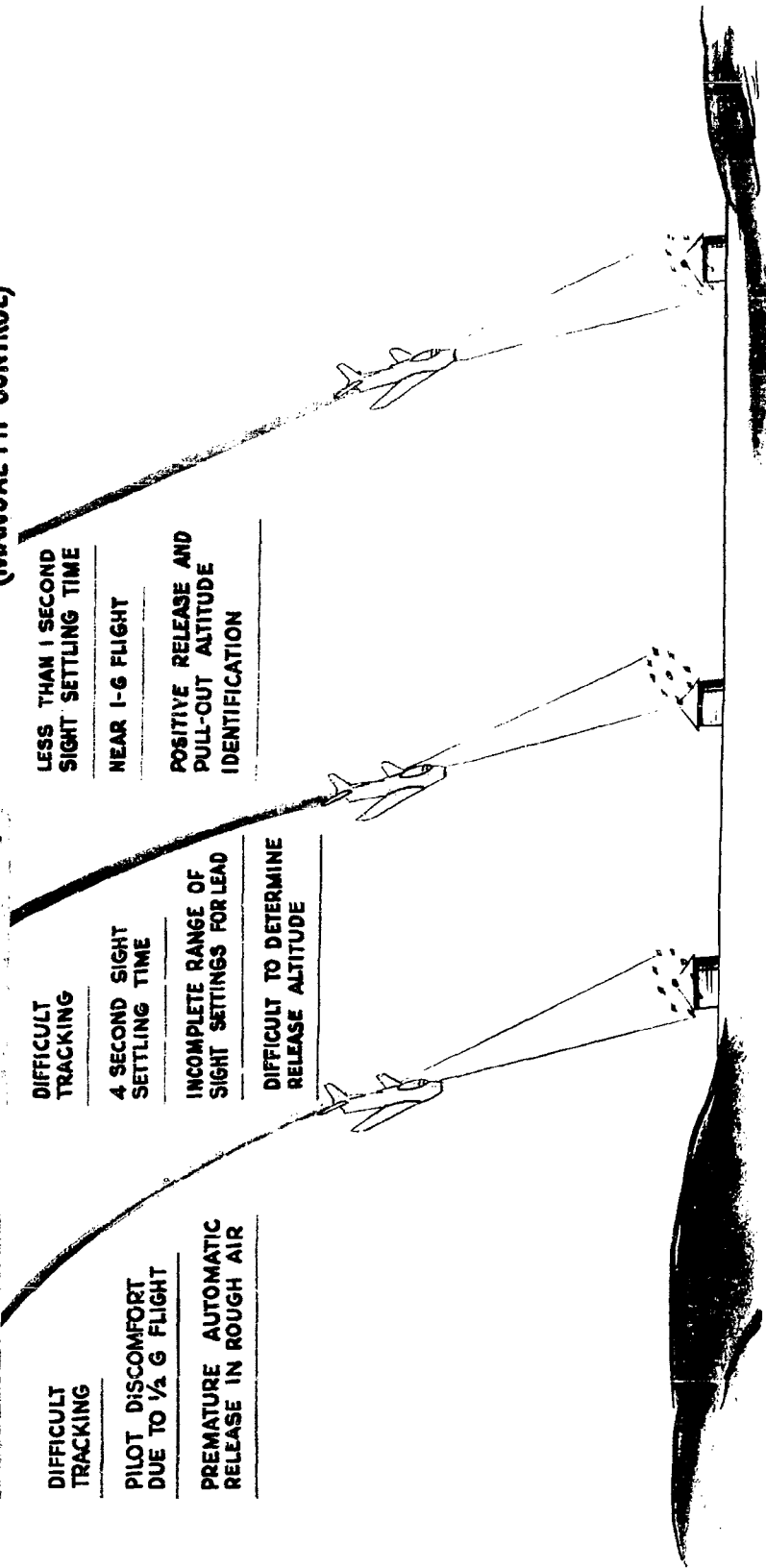
DIFFICULT TO DETERMINE RELEASE ALTITUDE

MODIFIED A-4 SOLUTION (MANUAL PIP CONTROL)

LESS THAN 1 SECOND SIGHT SETTLING TIME

NEAR 1-G FLIGHT

POSITIVE RELEASE AND PULL-OUT ALTITUDE IDENTIFICATION



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HIT REQUIREMENTS

Estimation of the important parameters of a dive bombing attack is difficult at best and will result in large miss distances if errors are made. For example, a mis-estimation of 20 knots in airspeed will result in a bomb missing the aim point by 60 feet. If the altitude at the point of release is off by 1000 feet, a bomb will miss by 100 feet, and a dive angle estimate that is in error by 10° results in a miss of 180 feet. If these errors are accumulative, as is usual in an actual dive bombing run, a total error of as much as 250 feet may be experienced, without accounting for any pilot induced tracking errors.

Test results have shown that it is very difficult for dive bombing pilots to estimate these parameters as closely as the limits noted here; dive angle within 10; release altitude within 1000 feet, and release airspeed within 20 knots.

The Manual Pip Control, bombing altimeter and canopy lines have been developed to provide these data to the pilot with a minimum of effort; thus enabling him to concentrate on the primary job of tracking and hitting the target.

Another important advantage of the MPC lies in its ability to "spot-light" the fundamentals of training by virtue of its straightforward mechanics - thus impressing students more quickly. Also, the extra safety provided by positive altitude identification cannot be overemphasized for students.

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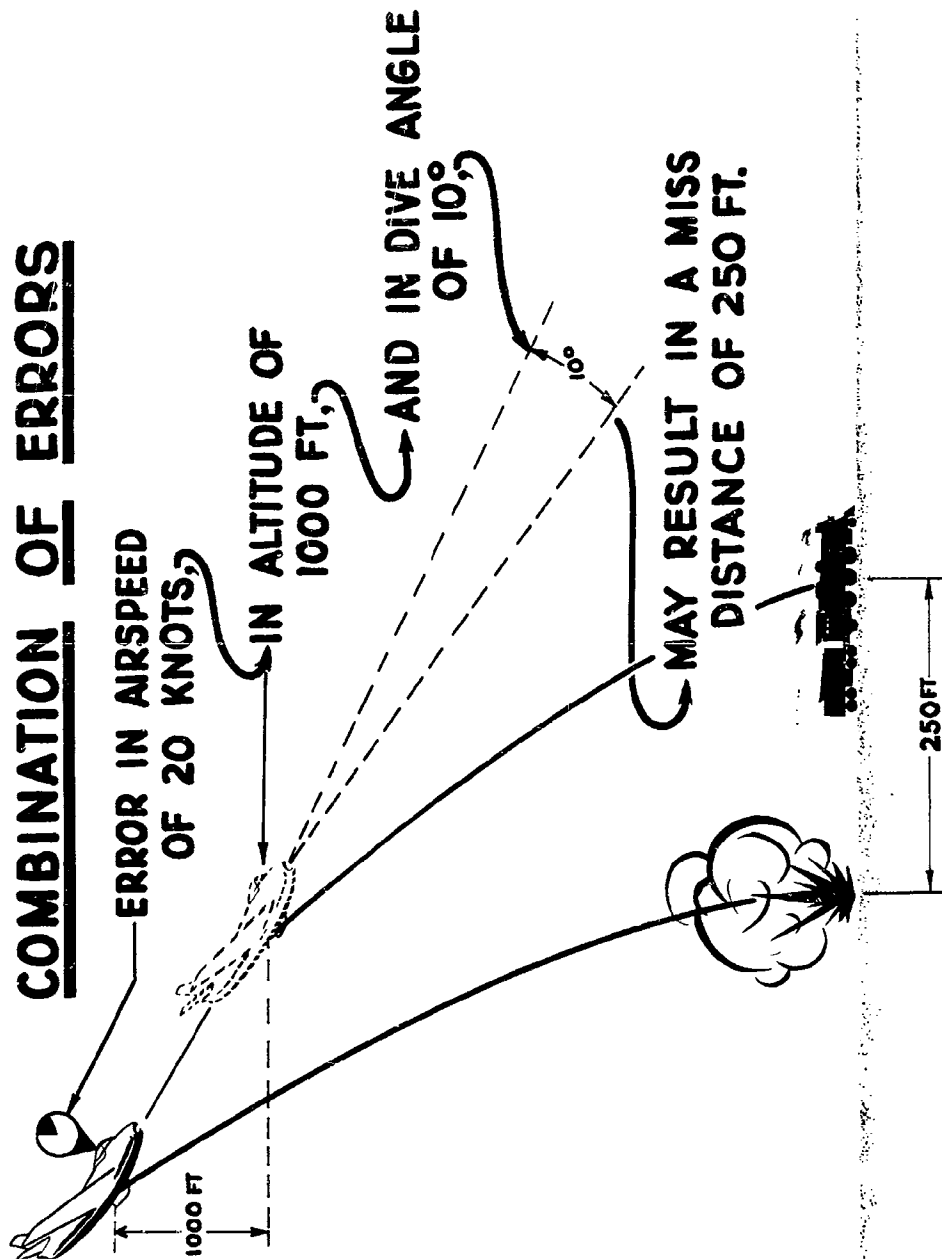
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THE PROBLEM

HIT REQUIREMENTS

GRAVITY DROP: SUMMARY

COMBINATION OF ERRORS



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IMPACT DATA

These are the bomb impacts from seven flights. The bombs were dropped in pairs, with 50% of the bombs within a circle of 100 foot radius. Four pairs of bombs were dropped on each flight, with the exception of one flight, where a malfunction of the bomb racks prevented release of the last pair.

These data are actual measured results, uncorrected for wind or aim error. No attempt was made to wait for weather, and crosswinds up to 60 knots were sometimes encountered.

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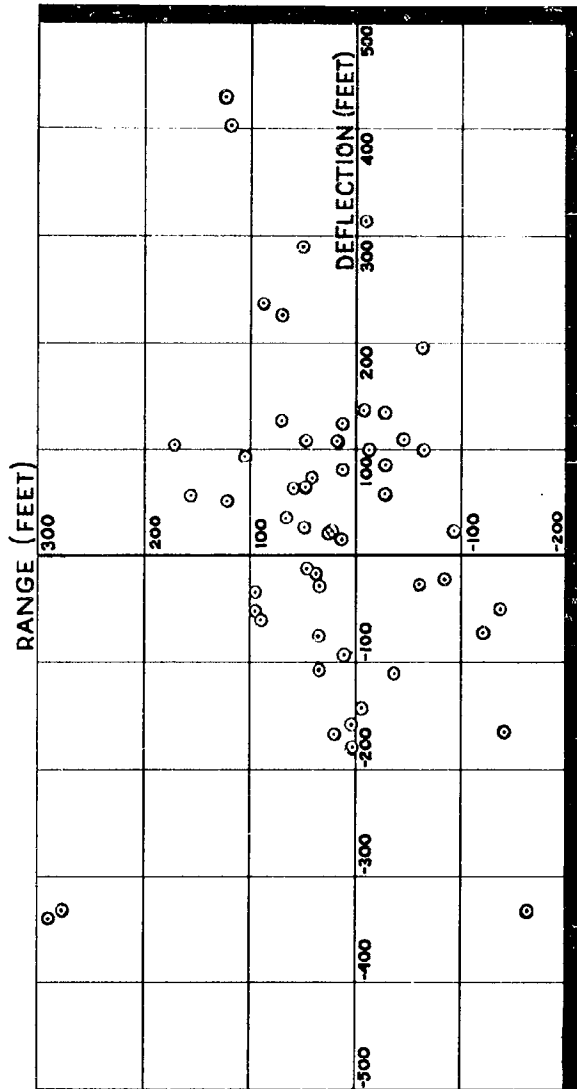


IMPACT DATA

NO WIND OR AIM ERROR CORRECTION

M-38 100 LB PRACTICE BOMBS

7 FLIGHTS - 27 PAIRS



Section 4

Production Change Point & Retrofit

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PRODUCTION CHANGE POINT AND RETRO-FIT

1. Belly Brakes

Large Side Speed Brake

Final tests being completed, proposal and schedule to be submitted.

2. Extended Leading Edge - Dry

F-86F 429 & Subs. (Los Angeles)

F-86F 272 & Subs. (Columbus)

Retro-fit has been proposed and accepted. Two hundred kits authorized.

3. Fuel Type - Extended Leading Edge originally proposed July 9 1952 -

acceptance not received

Being proposed for last 157 F-86F Airplanes at Los Angeles.

Kit Schedule to retro-fit Delivered Airplanes is currently being prepared.

4. Manual Pip Control

Bombing Altimeter

Canopy Dive Angle Lines

Proposed for Production and Retro-fit - January 20, 1953

To be accomplished on F-86F #1088 at Los Angeles

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1200 # Store -

To be accomplished on F-86F #1088 at Los Angeles

Kits are being proposed, and proposal is currently being submitted for a Contractor modification installation of Kits.

Structural provisions for this installation are on all dual store airplanes.

F-86F PRODUCTION ACCEPTANCES

[illegible]

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

FEB 19 2002

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)
8725 JOHN J. KINGMAN ROAD, SUITE 0944
FORT BELVOIR VA 22060-6218

FROM: AFMC CSO/SCOC
4225 Logistics Avenue, Room S132
Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review,
AFMC 01-242 (Atch 1)

→ (b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review,
AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review,
AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

LEZORA U. NOBLES
AFMC STINFO Assistant
Directorate of Communications and Information

Attachments:

1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:
HQ AFMC/HO (Dr. William Elliott)



DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

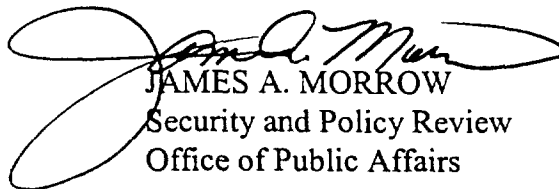
DEC 19 2001

MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 01-275

1. The reports listed in your attached letter were submitted for security and policy review LAW AFI 35-101, Chapter 15. They have been cleared for public release.
2. If you have any questions, please call me at 77828. Thanks.


JAMES A. MORROW
Security and Policy Review
Office of Public Affairs

Attachment:
Your Ltr 18 November 2001

18 December 2001

MEMORANDUM FOR: HQ AFMC/PAX
Attn: Jim Morrow

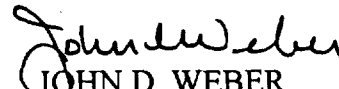
FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:
 - a. *Emergency Fuel Selector Valve Test on the J47-GE-27 Engine as Installed on F-86F Aircraft*, January 1955; DTIC No. AD- 056 013.
 - b. *Phase II Performance and Serviceability Tests of the F-86F Airplane USAF No. 51-13506 with Pre-Turbine Modifications*, June 1954; DTIC No. AD- 037 710.
 - c. *J-47 Jet Engine Compressor Failures*, 7 April 1952; DTIC No. AD- 039 818.
 - d. *Evaluation of Aircraft Armament Installation (F-86F with 206 RK Guns) Project Gun-Val*, February 1955; DTIC No. AD- 056 763.
 - e. *A Study of Serviced-Imposed Maneuvers of Four Jet Fighter Airplanes in Relation to Their Handling Qualities and Calculated Dynamic Characteristics*, 15 August 1955; DTIC No. AD- 068 899.
 - f. *Fuel Booster Pump*, 6 February 1953; DTIC No. AD- 007 226.
 - g. *Flight Investigation of Stability Fix for F-86F Aircraft*, 8 September 1953; DTIC No. AD- 032 259.
 - h. *Investigation of Engine Operational Deficiencies in the F-86F Airplane*, June 1953; DTIC No. AD- 015 749.
 - i. *Operational Suitability Test of the T-160 20mm Gun Installation in F-86F-2 Aircraft*, 29 April 1954; DTIC No. AD- 031 528.
 - j. *Engineering Evaluation of Type T 160 Gun and Installation in F 86 Aircraft*, September 1953; DTIC No. AD- 019 809.

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- k. *Airplane and Engine Responses to Abrupt Throttle Steps as Determined from Flight Tests of Eight Jet-Propelled Airplanes*, September 1959; DTIC No. AD-225 780.
- l. *Improved F-86F: Combat Developed*, 28 January 1953; DTIC No. AD- 003 153.
- m. *Flight Test Progress Report No. 19 for Week Ending February 27, 1953 for Model F-86F Airplane NAA Model No. NA-191*, 5 March 1953; DTIC No. AD-006 806.
2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.
3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.


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13 Attachments:

- a. DTIC No. AD- 056 013
- b. DTIC No. AD- 037 710
- c. DTIC No. AD- 039 818
- d. DTIC No. AD- 056 763
- e. DTIC No. AD- 068 899
- f. DTIC No. AD- 007 226
- g. DTIC No. AD- 032 259
- h. DTIC No. AD- 015 749
- i. DTIC No. AD- 031 528
- j. DTIC No. AD- 019 809
- k. DTIC No. AD- 225 780
- l. DTIC No. AD- 003 153
- m. DTIC No. AD- 006 806